1. Determine the Laplace transform of (10 %)

$$\int_{-1}^{t}(t-\tau)\tau e^{-\tau}d\tau .$$

2. (a) Determine the z transform of $n^2u[n]$. (14 %)
   (b) Determine the inverse z transform of $\exp(-z^{-2})$.

3. (a) Determine $\sum_{n=-\infty}^{\infty}\frac{\sin^2 n}{n^2}$ (14 %)
   (b) If $X(j\omega)$ is the continuous-time Fourier transform of $x(t)$, what is the continuous-time Fourier transform of $\mathcal{Re}\left[x(2t+1)\right]$?

4. Illustrate the following terms: (12 %)
   (a) stationary (for random process)
   (b) power spectral density
   (c) group delay
   (d) sampling theory

5. (20%) Consider a signal s(t) (with finite energy and duration) defined as:

   $s(t) = \frac{A}{2} \quad 0 \le t \le \frac{T}{2} \qquad s(t) = -\frac{A}{2} \quad \frac{T}{2} < t \le T$

   $s(t) = 0$ (Elsewhere)

   (a) (4%) Plot the impulse response of a filter, h(t), that is "matched" to s(t). (Note: h(t) should be causal).
   (b) (6%) Plot the output of h(t) (with s(t) as the input) as a function of time. What is the peak value of the output?
   (c) (10%) Let $y(t) = \sum_{n=-\infty}^{\infty} a_n s(t-nT) + w(t)$, where data sequence elements $a_n = \pm 1$ with equal probability and w(t) is a sample of white Gaussian noise with single-sided power spectral density N_0. Use the results of (a), (b) to find the bit error rate (BER) of an optimal detector for a_n. Also, plot the block diagram of this optimal detector with $y(t)$ as its input.

6. (6%) For demodulation of a carrier that is FM modulated by an analog baseband signal in the presence of additive white Gaussian noise (AWGN), which of the following demodulators can extend (i.e., reduce) the "threshold" CNR value?
   (a) balanced frequency discriminator.
   (b) quadrature demodulator.
   (c) phase locked loop (PLL) demodulator.

見背面

(d) FMFB demodulator.

(e) balanced frequency discriminator with pre-emphasis (at TX) and de-emphasis (at RX).

(f) zero-crossing detector, followed by a low pass filter.

(Note: Each correct choice gets +1 point, each wrong choice gets -0.5 points, leaving the whole problem unanswered (i.e., blank) gets 0 points, the minimum total points is 0)

7. (18%) Consider a quadrature-carrier multiplexing transmitter that generates an output signal of the form:

$s(t) = m_1(t)\cos 2\pi f_c t + m_2(t)\sin 2\pi f_c t$

where $m_1(t)$, $m_2(t)$ are two independent baseband message signals with the same bandwidth $W(\text{Hz})$ and $f_c \gg W$.

(a) (8%) For an ideal channel, plot a block diagram for the receiver and show how $m_1(t)$ and $m_2(t)$ can be separately recovered, assuming that a coherent local carrier signal is available at the receiver.

(b) (4%) Suggest some method(s) by which a local coherent carrier signal at the receiver in (a) can be generated.

(c) (6%) If the channel is NOT ideal and has a transfer function H(f) (note: H(f) is bandpass and has its center at $f = f_c$), what is the condition on H(f) so that $m_1(t)$ and $m_2(t)$ can still be separately recovered?

8. (6%) Consider digital transmission using raised cosine spectrum with roll-off factor α $(0 < \alpha \leq 1)$, indicate whether the following statements are true or false.

(a) For baseband transmission using 4-PAM, the bandwidth is $\frac{R_b}{4}(1+\alpha)$, (R_b is the bit rate)

(b) For QPSK passband transmission, the bandwidth is $R_b(1+\alpha)$.

(c) To preserve transmission bandwidth, we should try hard to have $\alpha \to 0$

(d) For 16-QAM passband transmission, the bandwidth is $\frac{R_b}{8}(1+\alpha)$.

(Each correct choice gets +1.5 points, each wrong choice gets – 0.5 points, leaving the whole problem unanswered (i.e., blank) gets 0 points, the minimum total points is 0)

試題隨卷繳回